Advancing Translational Space Research Through Biospecimen Sharing: Amplified Impact of Studies Utilizing Analogue Space Platforms

B. Staten[1], E. Moyer[1], V. Vizir[1], H.Gompf[2], T. Hoban-Higgins[2], L. Lewis[1], A. Ronca[1-3], C.A. Fuller[2]

[1]Space Biosciences Division, NASA Ames Research Center
[2]Department of Neurobiology, Physiology and Behavior, University of California, Davis
[3]Departments of Obstetrics & Gynecology, Wake Forest University School of Medicine

Motivation and Introduction

- ✓ Biospecimen Sharing Programs (BSPs) have been organized by NASA Ames Research Center since the 1960s with the goal of maximizing utilization and scientific return from rare, complex, and costly spaceflight experiments.
- ✓ The goal is to acquire otherwise unused biological specimens from primary space research experiments for distribution to secondary experiments.
- ✓ Here we expand biospecimen sharing to NASA Human Research Program (HRP) Human Health & Countermeasures (HHC)-funded ground-based studies utilizing analogue space platforms (e.g., Hindlimb Unloading (HLU) for rodent experiments, thereby significantly broadening the range of research opportunities with translational relevance for protecting human health in space and on Earth.

UC Davis and HRP HHC Biospecimen Sharing Collaboration

- ✓ A unique, long-duration HLU experiment involving young male, old male, and young female rats. Original NASA award covered only brain, eyes, and liver collection.
- ✓ Over 5,060 tissues have been collected from this one experiment that would otherwise have been wasted
- ✓ Spine, tail, lower limb bones, calvaria, and heart already distributed to secondary researchers

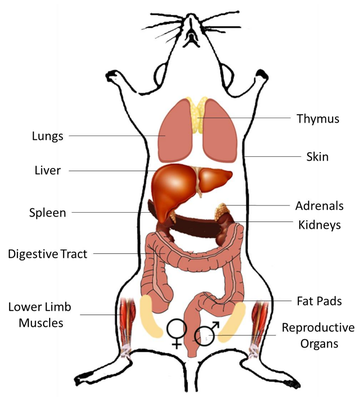

Figure 1. The additional tissue available for researchers

- ✓ Lungs, spleen, liver, skin, reproductive organs, fat pads, lower limb muscles, digestive tract, thymus, adrenals, and kidneys are all available for secondary experimentation (Figure 1).

Methods

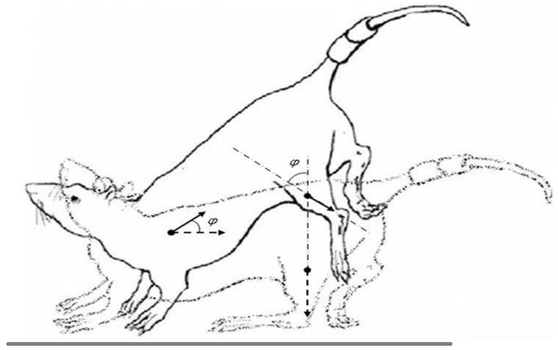

Figure 2. HLU rat model showing 30° angle between the ground and vertebral column, inducing hindlimb disuse and a cephalic fluid shift, analogous to conditions experienced during spaceflight. *Image credit: Mathematical Modeling of Cardiomyocytes' and Skeletal Muscle Fibers' Membrane: Interaction with External Mechanical Field, Ogneva et. al., 2013.*

- ✓ Young (3-month old) male and female rats, and Older (9-month old) male rats were exposed to HLU for either 7, 14, 28, or 90 days.
- ✓ Additional groups were exposed to 90 days of unloading followed by either 7, 14, 28 days or 90 days of recovery (normal loading).
- ✓ Tissues are harvested, weighed, and then preserved.
- ✓ This presentation shows organ masses of several organ systems
- ✓ Statistical significance was determined by yielding a p value < 0.05 for T-Tests, and a value > 0.05 for F-Tests.
- ✓ All tissue weights are a ratio of the individual tissue mass to the overall body mass.

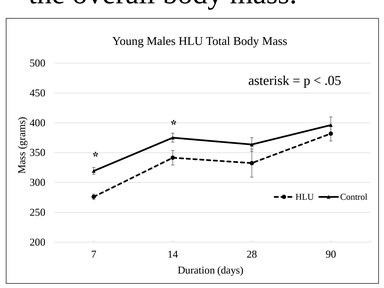

Figure 3. Total body mass of young male rats for a duration of 90 days in control and HLU environments.

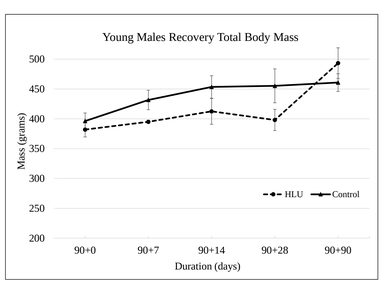

Figure 4. Total body mass of young male rats for a duration of 0 to 90 days recovery in control and HLU environments.

Results

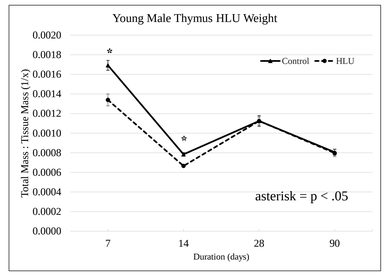

Figure 5. Combined weight of thymus glands in young male rats over a duration of 90 days in control and HLU environments.

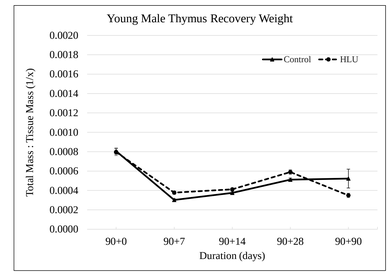

Figure 6. Combined weight of thymus glands in young male rats for a duration of 0 to 90 days recovery in control and HLU environments.

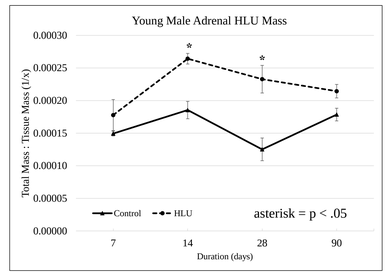

Figure 7. Combined adrenal gland mass of young male rats over a duration of 90 days in control and HLU environments.

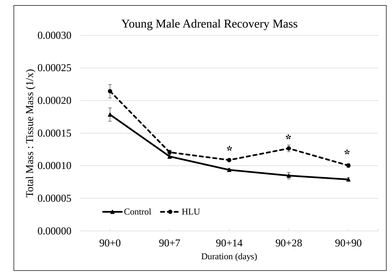

Figure 8. Combined adrenal gland mass of young male rats for a duration of 0 to 90 days recovery in control and HLU environments.

Future Considerations

- ✓ Identify collaborators for remaining available tissue
- ✓ Complete rest of tissue collection (July 2017)
- ✓ Correlate results from various collaborators to identify any relationships between organ systems as a result of long-term HLU

Acknowledgments & Reference

We acknowledge financial support from Human Research Program (HRP) Human Health Countermeasures (HHC) Element and NASA Grant NNJ13ZSA002N, and all those involved with the tissue harvesting.

Joseph S. Tash, Donald C. Johnson, George C. Enders. Long-term (6-wk) hindlimb suspension inhibits spermatogenesis in adult male rats. Journal of Applied Physiology Mar 2002, 92 (3) 1191-1198.